A COMPARISON OF THE IMMATURE STAGES OF *HYPOCHRYSOPS APOLLO APOLLO* MISKIN AND *H. A. PHOEBUS* (WATERHOUSE) (LEPIDOPTERA: LYCAENIDAE)

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Abstract

The immature stages and some life history details are described for the two subspecies of *Hypochrysops apollo* Miskin that occur in Australia. Eggs of *H. a. apollo* and *H. a. phoebus* (Waterhouse) were of similar size but those of *H. a. apollo* were pitted but otherwise smooth whereas eggs of *H. a. phoebus* had conspicuous ridges and spines. First and second instar larvae had the same basic patterns of setae but the setae of *H. a. apollo* were much shorter and more thickened or flattened than those of *H. a phoebus*. First instars also differed in the development of some of the glandular structures on the body. Larvae of both subspecies passed through at least eight instars before pupation under artificial rearing conditions. There were differences in oviposition site between subspecies, with eggs of *H. a. apollo* being laid closer to the leaves of the food plant, and in first-instar duration, with larvae of *H. a. phoebus* moulting sooner to the second instar, but these life history differences were confounded with differences in food plants and rearing occasions.

Introduction

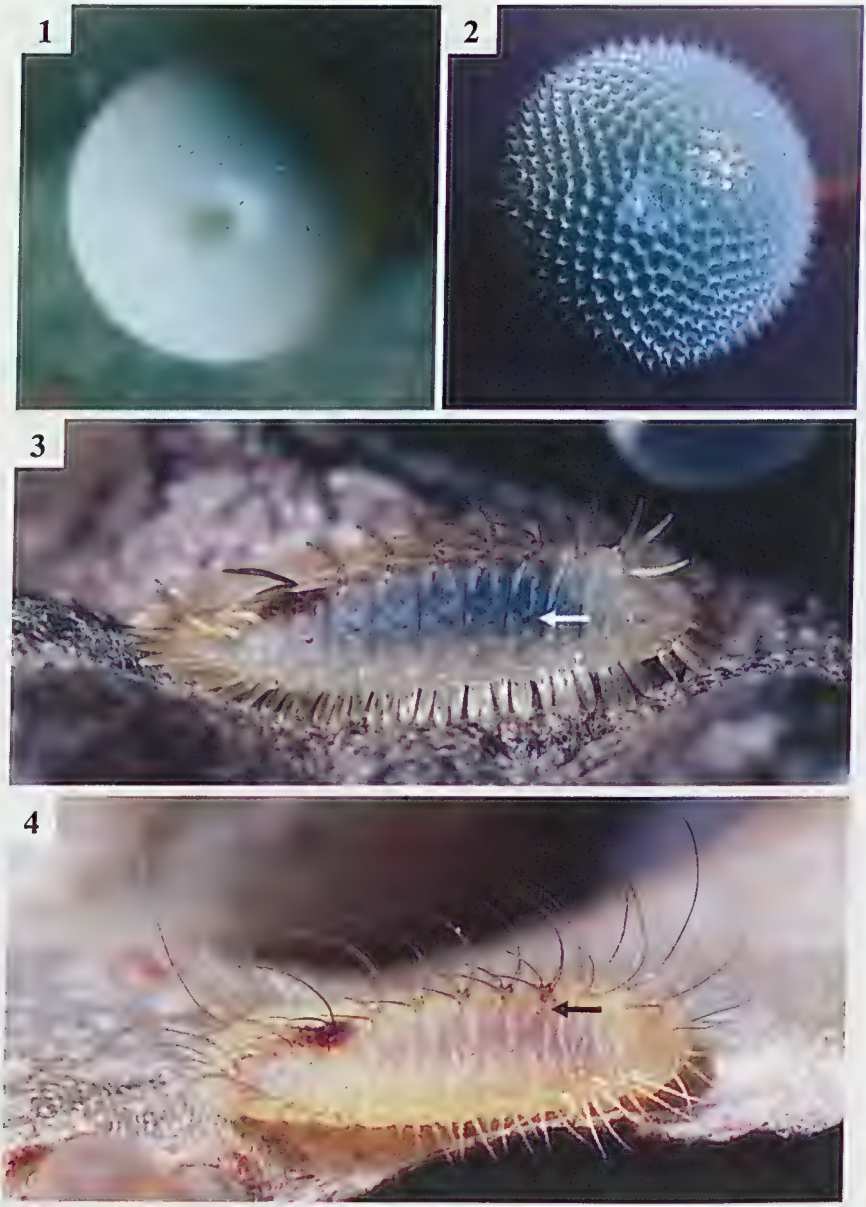
Hypochrysops apollo Miskin includes three subspecies, two of which occur in Australia: *H. a. apollo*, distributed from Cooktown to Ingham, and *H. a. phoebus* (Waterhouse), found north from the Rocky River in central Cape York Peninsula to Papua New Guinea (Braby 2000). Adults can be distinguished by colour and wing shape (Braby 2000).

Some aspects of the life history of *H. apollo* in Australia are well known and were summarised by Braby (2000). Larvae feed on species of ant-plant (Rubiaceae), including *Myrmecodia beccarii* in the southern parts of the range (*H. a. apollo*) and *M. tuberosa* in far northern Queensland (*H. a. phoebus*). Eggs are laid singly on the foodplant. Larvae live in the galleries that occur naturally within the plant stems and tubers and cohabit with ants, usually *Philidris cordatus stewartii* (Forel), which colonise the same galleries in large numbers. The larvae feed on the internal tissues of the plant and sometimes also on the leaves at night. Pupation occurs within the enlarged galleries inside the plant, the pupa being attached by anal hooks and a central girdle. The adult emerges through a hole made previously by the larva.

Braby (2000) gave a general description of large larvae and pupae without reference to subspecies and noted that the egg was not described. Here I describe the early stages of both Australian subspecies, with additional notes on their life histories, and document significant differences between them.

General descriptions for both subspecies

Egg (Figs 1-2). Diameter 1.2-1.3 mm. A flattened sphere with sunken micropyle, sculptured with pits or with ridges and spines depending on subspecies; pale green or bluish green soon after oviposition.



Figs 1-4. *Hypochrysops apollo*. (1-2) eggs: (1) *H. a. apollo*; (2) *H. a. phoebus*. (3-4) first instar larvae: (3) *H. a. apollo*; (4) *H. a. phoebus*. Conspicuous glands on A1 of first instar are indicated by arrows.

Figs 5-7. *Hypochrysops apollo*. (5-6) second instar larvae: (5) *H. a. apollo*; (6) *H. a. phoebus*. (7) *H. a. phoebus*, final instar larva.

First instar larva (Figs 3-4). Flattened with dorsal ridge and with middorsal tubercles on mesothorax (T2) to abdominal segment 5 (A5); four pairs of brown anterior setae on T1, two pairs on margin and two pairs slightly posterior to margin; T2-T3 each with two pairs of similar erect pale brown dorsal setae; A1-A6 each with two pairs of dorsal setae, pale brown on A1-A5 and dark brown on A6; numerous reclining setae on anal segments, the ultimate pair longer and curved upwards; three pairs of lateral setae on each of T1-A7; six pairs of posterior setae; fine ventrolateral setae, one pair per segment; body greyish, green or yellowish green, a reddish brown dorsal patch on A6-A7, sometimes with a reddish brown middorsal line on A1-A5, head pale brown. One pair of conspicuous circular epidermal structures (presumably glands) subdorsally or dorsolaterally on A1, subdorsally towards rear of each of A2-A5, dorsolaterally on A6 and dorsally on anal segments.

Second instar larva (Figs 5-6). Flattened with dorsal ridge and with middorsal tubercles on T2-A6; lateral margin deeply scalloped; T1 with three setae, one pair subdorsal and a single median seta, from rear of prothoracic plate; T2- or T3-A5 with short brown dorsal setae; tiny trumpet-shaped setae on dorsal tubercles; trumpet-shaped or fine marginal setae; short fine ventrolateral setae beneath scalloped margin; body greyish, darker dorsally, sometimes with reddish dorsolateral mottling and white subdorsal line, a reddish middorsal line on A1-A7, reddish lateral spots; prothoracic and anal plates glossy; head pale brown. Tentacular organs (TOs) present.

Third instar larva. Flattened with dorsal ridge and with middorsal tubercles on T2-A6; lateral margin deeply scalloped; one or two pairs of short dorsal setae on T2-A5 or -A6; numerous tiny trumpet-shaped setae; greyish, pinkish dorsally and dorsolaterally with cream lines subdorsally on T2-A5 and dorsolaterally and laterally on T2-A6, sometimes with reddish lateral line; prothoracic plate dark brown, anal plate pale brown with dark brown median and lateral patches anteriorly, TOs brown, spiracles dark brown. Newcomer's organ (NO) and TOs present.

Final instar larva (Fig. 7). Mottled pinkish brown and greyish cream, a broken white middorsal line with a posterior dark pinkish brown middorsal patch on each of T3-A6, an anterior dark pinkish brown patch on A7, a wavy greyish dorsolateral line and cream lateral line; prothoracic plate with dark brown spots dorsolaterally and on posterior margin, anal plate sunken, pinkish with dark brown dorsolateral spots and sometimes with an anterior 'V'-shaped marking, TOs brown, head brown.

Pupa. Pale brown, sometimes with reddish brown abdomen, speckled with dark brown; attached by anal hooks and central girdle.

Morphological differences between subspecies

The major differences between the immature stages of *H. a. apollo* and *H. a. phoebus* are listed in Table 1. These notes expand on the common details

given in the previous section. Eggs and larvae are clearly distinguishable until at least the third larval instar. Eggs of *H. a. apollo* have much reduced surface sculpturing, while early instar larvae have setae that are flattened or thickened and much reduced in length. Late instar larvae and pupae of the two subspecies are similar, although larvae of *H. a. phoebus* tend to be more strongly marked with darker spiracles.

Table 1. Morphological differences between the immature stages of *Hypochrysops apollo apollo* and *H. a. phoebus*.

Stage	Character	*H. a. apollo*	*H. a. phoebus*
Egg	Sculpturing	Tiny pits in oblique rows, without ridges or spines.	Fine oblique ridges forming four-sided cells, with short spines at their intersection.
First instar	Anterior setae	Flattened (on margin) or thickened (posterior to margin).	Fine.
	Dorsal setae	On T2-T3 thick; on A1-A6 thick, inner anterior pair erect, outer posterior pair broad basally and reclining.	On T2-T3 long, fine; on A1-A6 fine, inner anterior pair long and outer posterior pair shorter; ultimate posterior pair on anal segments very long.
	Lateral setae	Flattened, pale greenish brown.	Long, fine, branched, the anterior pair on A1-A7 basally flattened; pale brown.
	Posterior setae	Five pairs flattened, posterior median pair thin.	Long, fine, posterior median pair shorter.
	Conspicuous epidermal glands	Dorsolateral on A1; all glands similar in size.	Subdorsal on A1, subdorsal glands on A2-A5 smaller than others.
Second instar	Dorsal setae	On T1 tiny, trumpet-shaped with expanded tips; on T3-A5 thick.	On T1-A5 fine.
	Fine marginal setae	Absent.	Numerous.
	Prothoracic plate	Uniform colour.	Dark brown dorsal patch posteriorly.
Third instar	Dorsal setae	Club-shaped, absent from A6.	Fine.

Life history notes

Hypochrysops a. apollo

I observed or collected immature stages of this subspecies on *Myrmecodia beccarii* attached to mangroves east of Innisfail, northern Queensland. Unhatched eggs were present on 5 November 2003, 26 March 2004 and 1-3 November 2005. I found a total of 36 eggs, 13 unhatched and 23 hatched and, of these, 19 were attached to small tubers, less than about 5 cm diameter, which often grew at the base of larger plants. Sixteen eggs were attached to leaves and 19 were close to a leaf base on stems or small tubers. Only one egg was found on a large tuber distant from the leaves.

A first instar larva was found on 5 November 2003, on young leaves on a small tuber of 2-3 cm diameter, with a hatched egg on the tuber. The larva had been feeding on the very youngest leaf on the plant. First instars that emerged in captivity also ate young leaves, chewing tiny circular holes or eating scallops from the margins. Many continued feeding exposed on young leaves throughout the instar but one, having fed on leaves for a day, entered into a small tuber via one of the tuber openings and was subsequently found inside the tuber as a second instar. First instars were seen to be palpated by ants on occasions but were often unattended. Large larvae in captivity were supplied small pieces of tuber and leaves and fed on both.

Days to hatching of 11 eggs collected in November ranged up to 7 (two eggs), 8 (one egg) and 9 (one egg). Mean duration of the first instar was 5 days (4-6 days, $n = 7$). Only one larva was reared from egg to pupa, with a larval duration of 111 days. The number of instars that this larva passed through is uncertain, as at least one moult was not observed but, by interpolation of expected instar durations, is believed to have been 10 or 11.

Hypochrysops a. phoebus

I observed or collected immature stages of *H. a. phoebus* from 24-29 May 2005 at two sites, near Punsand Bay and at Iron Range, Cape York Peninsula. Food plants are believed to have been two species of *Myrmecodia*, *M. platytyrea* near Punsand Bay and *M. platytyrea* and *M. tuberosa* near Iron Range, based on their distributions and descriptions given in Huxley and Jebb (1993), and a third very different ant-plant, consistent with *Hydnophytum moseleyanum* (= *H. papuanum*) as illustrated by Williams (1987), in both areas. However, no plants were collected for positive identification.

Of 14 unhatched eggs found on *Myrmecodia* spp., two were on the swollen tuber base and the remainder were on the thick stems, often attached to spines. Many hatched eggs were also found on *Myrmecodia* stems and tubers. No eggs were found on the leaves. A hatched egg was also found near Punsand Bay on the ant-plant tentatively identified as *H. moseleyanum*, attached to a spine on the swollen tuber near the point of attachment of the multiple stems.

First instar larvae, when placed on a piece of *Myrmecodia* stem, ate tiny holes in the fleshy green 'spines' around the rim of the shield-shaped structures (clypeoli) surrounding each leaf base. However, feeding was minimal and the duration of the stage was short (see below). Ants confined with the larvae were not observed to interact with them at all. Large larvae ate both the pieces of tuber and the leaves that were supplied as food.

Individuals collected as eggs in May were kept at ambient temperature in far northern Queensland until mid-way through the second instar, when they were transferred to a constant 26°C. The longest time to hatching of 11 eggs was 7 days (three eggs). All first instars moulted to the second in 3 days (n = 9). Three larvae were reared from egg to pupa, with durations of 72 days (eight larval instars, male), 88 days (nine larval instars, female) and 89 days (nine larval instars, died as pupa). The pupal stage occupied 15 and 17 days for the two pupae that successfully produced adults.

Discussion

Larvae of *H. apollo* passed through at least eight larval instars; more than is usual for most lycaenid larvae. However, larvae of two other species of *Hypochrysops* C. & R. Felder, *H. hippuris nebulosis* Sands and *H. elgneri barnardi* Waterhouse, have been recorded as passing through six and seven larval instars, respectively (Samson 2002). Larvae of *Paralucia aurifera* (Blanchard), in a related genus within the tribe Luciini, passed through five or six instars if ants were present and six or seven instars if ants were absent (Cushman *et al.*1994). I reared larvae of *H. apollo* without ants and the food supplied to the larva of *H. a. apollo* in particular was occasionally of poor quality; these factors could have led to an increase in the number of instars (Cushman *et al.* 1994, Esperk *et al.* 2007).

Although the basic morphology of the early immature stages of *H. a. apollo* and *H. a. phoebus* was similar, there were some marked differences. Eggs were of similar size but those of *H. a. apollo* were pitted, whereas eggs of *H. a. phoebus* had conspicuous ridges and spines. First and second instars had the same basic patterns of setae but the setae of *H. a. apollo* were much shorter and thickened or flattened, a difference which was still apparent but less pronounced in the third instar. First instars also differed in the development of some of the glandular structures on the body. Differences between the subspecies were less obvious in later instars and final instar larvae appeared morphologically similar.

I also recorded differences in oviposition site and first instar biology, but these were confounded with differences in host plants and time of year. According to the recorded distributions of *Myrmecodia* spp., *M. beccarii* is the predominant species within the range of *H. a. apollo*, although *M. platytyrea* is also found near Daintree and Mossman; *M. beccarii* does not occur within the range of *H. a. phoebus* (Huxley and Jebb 1993, P.I. Forster pers. comm.). I found eggs of *H. a. apollo* mainly on or near young leaves of

M. beccarii, often on juvenile plants, whereas most eggs of *H. a. phoebus* were found on tubers or tuber stems. First instar larvae of *H. a. phoebus* fed sparingly in captivity and moulted to the second instar sooner than larvae of *H. a. apollo*. Simultaneous rearing of both subspecies on the same food plant would be needed to see if these differences are real.

Eggs and early instar larvae of *H. a. phoebus* from Punsand Bay (10°44'S) and Iron Range (12°44'S) were similar, these sites being near the northern and southern limits of the subspecies' range on the Australian mainland (Cape York to the Rocky River: Braby 2000). Although the above descriptions of the immature stages of *H. a. apollo* are all based on specimens from near Innisfail (17°30'S), an egg I collected previously at Cooktown (15°32'S), at the northern limit of this subspecies' range, was noted to have been pitted and without spines, while the first instar that emerged had short, flattened setae similar to those described above (PRS unpubl. notes). Thus, there is reason to believe that the descriptions recorded above are generally applicable to populations referred to either *H. a. apollo* or *H. a. phoebus* on the Australian mainland. *H. a. phoebus* also occurs on islands in the Torres Strait and in Papua New Guinea (Braby 2000), but no immature specimens have been examined from these localities. It would be of interest to examine these and also to determine if *H. apollo* occurs on the east coast between Silver Plains (13°46'S, near the Rocky River) and Cooktown, an area from which there are also no voucher specimens of ant-plants in the Queensland Herbarium (although there is at least one unvouchered record of *M. beccarii* from Starcke, 15°04'S: P.I. Forster pers. comm.).

The marked differences reported above support the taxonomic separation of *H. a. apollo* and *H. a. phoebus* to at least subspecific level and raise the possibility that they might not be conspecific.

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